Calculations of the Proliferation-Resistance of Recycled Fuel

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One of the central concepts for the Global Nuclear Energy Partnership (GNEP) is the reduction of proliferation risks while expanding the global nuclear power industry. Achieving this goal requires an advanced reprocessing and recycling technology for the spent fuel. The present scheme being considered does not separate plutonium from other long-lived radioactive elements and thus requires detailed modeling to characterize the fuel.

In an effort to quantify the proliferation issues, we have been modeling the nuclear burn of these advanced fuels using the Los Alamos reactor burn code Monteburns, which couples the MCNP transport code and the nuclear transmutation code CINDER'90. With this tool we can provide an accurate description of a broad class of fuels, including the reactor spatial and temporal power, the fuel composition, and the radiation and decay heating. We characterize the waste content and emission and examine several non-pure plutonium fuels in fast reactors to determine radiation signatures for advanced safeguards.

We have determined and verified the characteristic radiation signatures of irradiated fuel assemblies for Th-U fuels (see Fig. 1). These calculations provide detailed spectra of neutrons, gamma, betas, and charged particles emitted from the spent fuel as a function of cooling and/or storage time. We have examined the proliferation index of these fuels and shown that unless 20% of lightly enriched uranium is included in the fuel, the proliferation index is violated.

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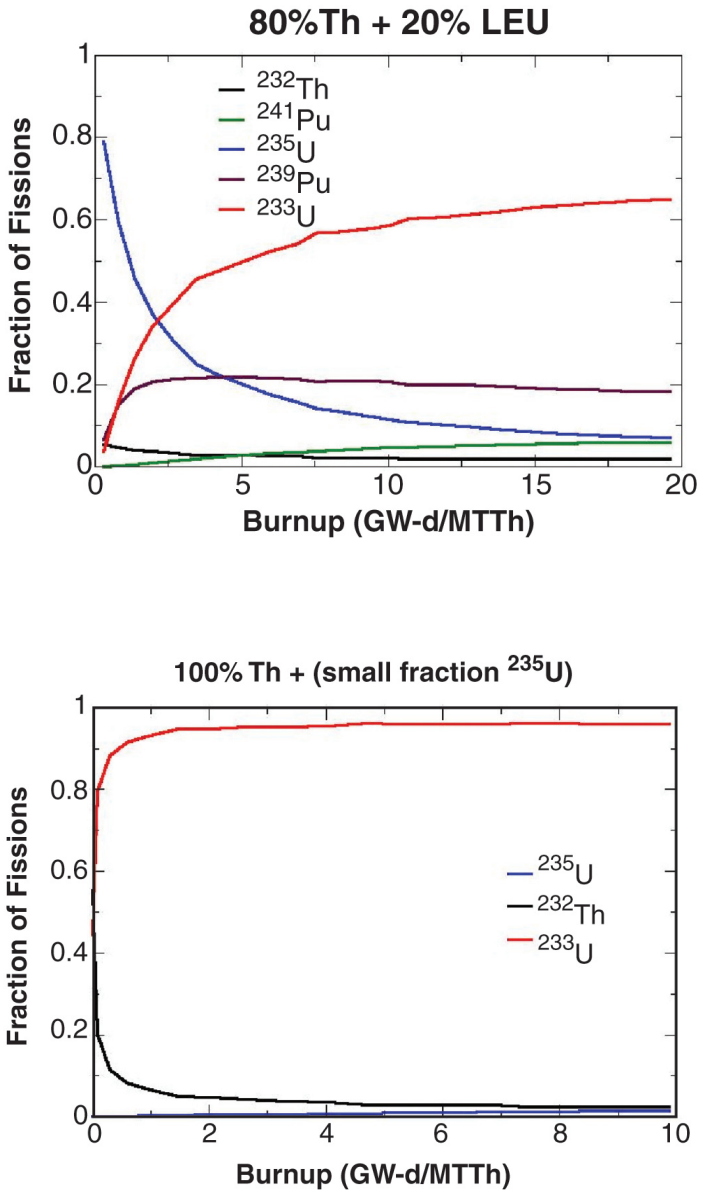

Fig. 1.
Fuel burnup for the Th-U fuel. The curves show the fraction of the different isotopes burning as a function of time. (top) Shows the burn for normal Th-U fuel. (bottom) Shows the burn for the Th-U fuel that violates the proliferation index. Units in labels of x-axis = Giga Watt-day/metric ton of Th.